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ABSTRACT

Two content-independent learning strategies were evaluated to determine their effectiveness in facilitating learning on two types of information-processing tasks, spatial learning and concept learning. The network strategy used imagery with a peg-mnemonic and a hierarchical retrieval system, while the rote strategy elicited a stimulus-response type of learning. A slide-tape instructional program on the human heart was used with 60 college students. The slides used either line drawings with a color background or illustrations in color. Subjects were trained in the use of their strategy by the instructor and they practiced with training slides. The network strategy was more effective for later performance with a concept-learning task. However, the rote strategy did not differ significantly from the network strategy, indicating that even a low-level information-processing strategy is better than no strategy. The network strategy provided learners with an information-processing advantage by allowing more effective information encoding for later retrieval for the spatial learning task. The rote learning strategy apparently acted much like the learners' idiosyncratic learning strategies in the control group. Results imply that learners can benefit from learning strategies of a content independent nature. (Author/LMM)

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Content Independent Learning Strategies And Their Relative Effectiveness On Acquiring Concept Information And Spatial Information When Learning From Visualized Instruction

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Introduction

Research on the topic of learning strategies and naturally ocurring information processing strategies is currently receiving a significant amount of attention in the areas of Cognitive Psychology and Experimental Psychology. Learning strategies investigated relate to the internal cognitive representations of information in imagery and sequential form. Additionally, such learning strategies tend to be independent of specific content to-be-learned or the specific instructional method. The following study further investigated the research topic of content-independent learning strategies. Specifically, two learning strategies were evaluated for facilitating learning on two types of information processing tasks. The two strategies evaluated were the Network Strategy and the Rote Strategy. The Network Strategy had the information processing advantages of imagery, a peg-mnemonic and a hierarchical retrieval system. The Rote Strategy elicited a stimulus-response type of learning. Stimulus-response learning, or incremental learning, can be defined as rote learning and is the opposite of insightful learning or a hypothesis testing type of strategy. The two information processing tasks were spatial learning and concept learning. The Network Strategy was superior on both learning tasks and the Rote Strategy performed much like the control group on both the spatial and the concept task.

Summary of Cognitive Learning Strategies

The current emphasis with research in cognitive learning strategies, while still theoretical in nature, has stressed content-independent learning strategies. The content-independent learning strategy is relatively independent of a specific academic discipline, course subject, or

instructional method, (Rigney, 1978). Therefore, the content-independent learning strategy could be used across subject areas to help learners acquire facts, concepts or procedures. The content-independent learning strategies investigated operationally relate to the mental or cognitive manipulation of information to-be-learned, and have been aimed at improving the general information processing skills of the learner (Dansereau, Long, McDonald, Actkinson, Ellis, Collins, Williams, Evans, 1975). Dansereau et.al. (1975) have concentrated on imagery learning strategies, paraphrasing strategies and question/answer mathemagenic learning strategies, and found considerable success with the imagery and paraphrasing learning strategies, (Dansereau, Actkinson, Long; 1974);

> "The training program dramatically improved long-term retention of academic material. Consistent differences between the three training groups indicated that the paraphrase and imagery techniques should undergo further refinement and testing, the question-answer strategy should be dropped."

Content-independent learning strategies that are related operationally to a specific cognitive representational system (e.g. imagery, propositional, or dual-coding) have been particularly successful in producing significant differences between experimental and control groups. Hilgard and Bower (1975) refer to dual-coding as an explanation for the large differences in dependent means between experimental and control groups in imagery and imagery strategy studies. Hilgard and Bower (1975):

> "A large number of learning experiments have now been done indicating that imaginal or pictorial representations of information usually facilitates memory by factors ranging from 1.5 or 3.0, (p. 588)."

Learners can be taught to use specific information processing or learning strategies that relate operationally to the cognitive representational systems, however, a number of naturally occurring information processing strategies have been identified by Bower (1972). Bower (1972) points out that learners do develop information processing strategies on their own, and he identified the:

(1) Search for meaning strategy

(2) Generative rule strategy

(3) Mnemonic pegword system

(4) Hierarchical retrieval strategy

All of these information processing strategies occur naturally, and they relate operationally to the cognitive representational systems. In the search for meaning strategy the learner compares new information to existing information in the cognitive structure in an effort to find meaning in the new information. This behavior was originally noticed by Bartlett as early as 1932, and he labeled it "effort after meaning," (Mayer 1977, p. 107). The generative rule strategy is actually a conceptual rule. The concept rule allows the person to efficiently deal with stimuli by allowing the categorization of information into a conceptual catagory or out of that category.

The mnemonic pegword system is a particularly powerful memory strategy. The mnemonic pegword usually involves imagery, such as the loci method or rhyme mnemonic method. As many of you may have observed, a mnemonist showman can easily recall 50-60 individual names perfectly, after hearing them once! Finally, the hierarchical retrieval system operates on the idea of "clusters" of information being stored, with each

cluster of data being logically interrelated forming a network or hierarchy. For example: if you have 100 items to recall, and can identify 5 clear categories of data, it would be more effective in terms of retrieval, to store the data as 5 clusters of 20, than to try to commit to memory 100 independent bits of information! In this case each cluster represnts a stable and clear set of stored information. Additionally, once the cluster of related information is retrieved the subordinant elements in the cluster, could be easily recalled. The idea of memory sets and the storage of clusters of information is directly related to Tulving's (1968) now classic theory on subjective organization. Gagne (1977) also considers the idea of naturally occurring information processing strategies and operationally defines them as an acquired skill. Essentially, Gagne considers learning strategies the acquisition of skills involving 'learning how to learn.'

However, while a number of learning strategies which regulate information processing do occur, they will tend to vary in effectiveness, (e.g. consider the difference between learning for rote and learning for meaning). Goldman and Hudson (1973) compared high, middle and low, grade point average high school learners and found them to vary significantly on type of learning strategy used not on innate intellectual ability. Weinstein (1978) indicates that the assumption most schools make is that learners are equipped with effective learning strategies when they arrive at school at the primary levels. She goes on to indicate that this is a total misconception and should be remedied by training learners to use effective learning strategies.

Design and Procedures

The present study further investigated the topic of cognitive learning strategies. The two learning strategies evaluated were the Network learning strategy and the Rote learning strategy. Learning performance was evaluated on a concept learning task and a spatial learning task. To-be-learned content information was presented to learners via a slide/tape instructional program on the topic of the diastolic and systolic operations of the heart. There were two media formats making up two separate slide/tape programs:

(1) line drawing slide sets with a color background

(2) illustration slide sets in color (adapted from Dwyer 1967).

Additionally, there was a repeated measures factor, a one week delay in testing. The experimental design of this study was a 2x3x2 mixed analysis of variance with repeated measures.

		Line Drawing Slides	Color Illustration Slides
Immediate Testing	Networking Strategy		
	Rote Strategy		
	Control Group		
Delay Testing	Networking Strategy		
	Rote Strategy		
	Control Group		

Example of experimental design.

The network learning strategy was a combination of a mnemonic peg-word strategy and a hierarchical retrieval strategy (e.g. previously discussed in Bower, 1972). Subjects using the network strategy had the information processing advantage of imagery, a mnemonic memory device, and a hierarchical retrieval system. Subjects learned to use the network strategy in a training session conducted by the experimenter. Through a detailed set of explanations and practice they learned how to; form mental images, use a peg-mnemonic and use a hierarchical retrieval system. The rote learning strategy group learned to perform a stimulus-response type of learning. They learned to memorize by associating each element to the next element in the set of to-be-learned data, until the entire set could be recalled. This 'mental association' of stimulus elements resembles a typical rote learning procedure students often use in academic learning situations, (e.g. memorizing a list of dates, a listing of poet's names, etc.).

Subjects consisted of 60 graduate and undergraduate students from the Ohio State University. Subjects were pre-tested via an interview to determine prior knowledge with the content material they would learn later (e.g. diastolic and systolic heart phases). Significant prior knowledge levels were not evident. All 60 subjects were then randomly assigned to one of the three strategy groups; (1) networks, (2) rotes, (3) controls.

Subjects were trained on the use of their strategy from a set of pre-prepared instructions read to them by the instructor. Each strategy training session lasted 30 minutes and subjects were kept on-task for the entire 30 minute period. Subjects were trained in small groups of 3 to 6 at a time. Subjects learned and practiced their strategy by viewing a set of of 16, 2x2 slides. The slide set consisted of illustrations of a

water pump filtering system, with one slide showing the overall system and the 15 other slides showing each part making up the system. Each slide also contained a label naming the particular part shown. The Networks and Rotes both used the same training slides, but of course they were required to perform different tasks during strategy training. The control group also saw the set of slides used to train the other two groups. The control group was told that they were to evaluate the media quality of the slides. Their evaluation session lasted 30 minutes. The training slide set was shown to the controls to avoid contamination effects due to advance organization.

The following day subjects were randomly assigned to one of two slide-tape programs about the parts and functions of the human heart. The content in the two programs was identical, they varied only in the complexity of visualization. One program consisted of slides that were line drawings, the other program consisted of a set of slides that were color artist illustrations of the heart. The slide-tape program lasted exactly 22 minutes. After the program was over two dependent measures were given subjects. One measure was a concept learning task, the other a spatial task. The concept learning task was a 20 item multiple-choice test which tested general concept learning. The spatial task required the learner to correctly label all the parts of the heart in the drawing. There were two forms of the spatial task dependent measure. One form was an illustration drawing of the heart, which resembled the artist's illustrations in one of the slide-tape programs. The second form was a line drawing of the heart, which resembled the line drawings in the other slide-tape program. This was done to eliminate any contamination due to type of cues provided in the drawing and the type of slides seen in the slide-tape program. Subjects seeing the line drawing slide-tape program

received the line drawing spatial task measure; subjects seeing the illustration slides received the illustration spatial task measure. The spatial task was a cued recall task and had 17 possible points. Both the slide programs and the dependent measures were adapted from Dwyer (1967). One week later subjects received both dependent measures again as a measure of long term retention.

Results & Discussion

Two separate analysis of variance with repeated measures (ANOVR) were conducted on the dependent measures, one for the concept learning task, one for the spatial learning task. The statistical design implied a 2x3x2 ANOVR. Follow-up tests were conducted on significant effects, where required using a Tukey method set at .05 alpha.

The concept learning task dependent measure represented a general concept learning ability. The measure consisted of 20 multiple-choice items of relational concept questions and conjunctive concept questions. The concept learning measure analysis yielded significance on the strategy variable, $F,(2,54\ df) = 5.014$, $p = .01$. Follow-up testing found the network strategy ($\bar{X}.= 12.98$) to differ significantly from the control group ($\bar{X}.= 9.73$). The network strategy ($\bar{X}.= 12.98$) did not differ significantly from the rote strategy ($\bar{X}.= 10.4$), however, the mean's difference approached significance. The rote strategy ($\bar{X}.= 10.4$) did not differ significantly from the control ($\bar{X}.= 9.73$).

The network strategy provided for a more effective information processing of material from the slide-tape program for later performance with a concept learning task. Interestingly, the rote strategy did not differ significantly from the network strategy, indicating that even a low level information processing strategy is better than no strategy.

However, it can be argued that the controls did use their own idiosyncratic strategy, which may have been similar to a rote strategy since these two means are so close (e.g. $\bar{X}$,rote= 10.4/$\bar{X}$,control= 9.73).

No significant interactions occurred in the concept task analysis. The time variable yielded significance F,(1,54 df) = 36.3, p = .004, indicating a general difference between immediate testing ($\bar{X}$.= 11.58) and delayed testing ($\bar{X}$.= 10.48). However, this is not a particularly interesting finding.

The spatial learning task was a cued recall measure. The subject had to correctly label each part of the heart discussed in the slide-tape program. Analysis yielded significance on the strategy variable F,(2,54 df) = 13.904, p = .0001. Follow-up tests indicated that the network strategy ($\bar{X}$.= 12.98) differed significantly from the rote strategy ($\bar{X}$.= 8.93). The network strategy ($\bar{X}$.= 12.98) differed significantly from the control ($\bar{X}$.= 6.85). However, the rote strategy ($\bar{X}$.= 8.93) did not differ significantly from the control ($\bar{X}$.= 6.85).

The network strategy provided learners with an information processing advantage by allowing them to more effectively encode information from the slide-tape program for later retrieval for performance on the spatial learning task. The rote learning strategy apparently acted much like the learners' idiosyncratic learning strategies in the control group. It can be concluded from this result that subjects in the control group tended to use a processing strategy quite similar to a rote strategy. This put both groups at an information processing disadvantage when compared to the network strategy.

The strategy by time interaction was significant, F,(2,54 df) = 16.31, p = .01. Follow-up testing finds the source of the interaction to be with the rote strategy and the control. The network strategy means did not

differ across the time period of one week ($\bar{X}$,immediate= 13.3; $\bar{X}$,delayed= 12.65). However, a significant amount of information was lost between the immediate and delayed testing period for the rote strategy ($\bar{X}$, immediate= 9.95; $\bar{X}$,delayed= 7.90), and the control ($\bar{X}$,immediate= 8.45; $\bar{X}$,delayed= 5.25).

The strategy by time interaction results are particularly interesting since the network group clearly outperformed the rotes and controls in terms of retrieval over the time period of one week. The conclusion from this is that an effective information processing strategy does improve the encoding of information as well as the retention of information for later retrieval. Interestingly, the control group's idiosyncratic learning strategy was quite similar to a rote strategy, since these two groups did not differ in their pattern of performance. This implies that many learners may be using a rote strategy when in a unique learning situation.

The other interactions in this analysis were not significant. Significance was found on the time variable, $F=(1,54\ df) = 35.34$, $p = .0001$. However, this result is not interesting and simply indicates a general loss of information over time ($\bar{X}$,immediate= 10.57; $\bar{X}$,delayed= 8.6).

Directions for the Future

The results of this study imply that learners can benefit from learning strategies of a content-independent nature. Additionally, strategies that are designed to facilitate the learner's encoding, retention and retrieval of information, by training them to mentally manipulate information, can be effective for typical learning tasks. Finally, it seems that learners may employ a rote type of learning strategy when left

to their own, in some cases, putting them at a disadvantage in the learning situation. Further research is needed in the area of content-independent learning strategies. Future research efforts should refine specific strategies that can be used by learners to facilitate their learning on typical academic learning tasks. A key factor in success on academic learning tasks is the type of cognitive information processing strategy used by the learner, yet little applied conclusions have been made in this vital area so learners can be provided with a variety of learning strategies aimed at facilitating their learning.

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